others. I cannot attempt to explain many of the facts I have set forth in this memoir; and yet an explanation ought to be forthcoming, and particularly in reference to the microscopical part of the subject on which I have mainly been able to dwell. The exact relations of the number and size of the barbules and hamuli to the sounds they produce is worth investigating, and still more is the cause of the breaks in the continuity of the sounds which you have heard—or, rather, not heard. This last would need the application of one who is intimately acquainted with the science of acoustics, which I make no pretence to be, and therefore I cannot offer any suggestion which will account for the non-continuity of the "bleating" or "humming"—its sudden stops and its sudden recurrence. There is much more to be learnt in this matter, and I would pray those who may be unconvinced by my experiments, at least to try to account for those marvellous sounds in some manner more satisfactory, and I assure them that there is no one who would be better pleased than myself to find that they can be so accounted for.

In conclusion, I should like to tender my sincere thanks to Prof. Newton, of Cambridge, without whose assistance the above facts would never have been recorded.

Since reading this paper I have received a skin of a female specimen of *G. æquatorialis*. The sound produced is disappointing in volume; in tone it bears a resemblance to that of the bleat of *G. cœlestis*.

3. Contributions to the Knowledge of the Systematic Arrangement and Anatomy of certain Genera and Species of Squamata. By Frank E. Beddard, M.A., F.R.S., Prosector to the Society.

[Received December 7, 1906.]

(Text-figures 10–19.)

Contents.

(1) *On some Specific Characters of Chamæleons shown in the Internal Organs.*

The external differences among Chamæleons are plainly set forth in vol. iii. of Boulenger's 'Catalogue of Lizards in the

British Museum.' The differences between the viscera of different species are by no means so well known. Indeed the only recent memoir known to me dealing with the visceral anatomy of Chamæleons, which also refers to specific differences within the genus, is that by Dr. Wiedersheim*, chiefly dealing with the respiratory system in *Ch. vulgaris* and *Ch. monachus*. I have dissected, with reference to more than one point in the visceral anatomy, the following species, viz.:—*Ch. vulgaris*, *Ch. calcarifer*, *Ch. dilepis*, *Ch. pumilus*, *Ch. parvilobus*, *Ch. tæniobronchus*, *Ch. basiliscus*, and *Ch. verrucosus*. I am in consequence able to offer some additional anatomical facts concerning the genus, which are also of classificatory importance.

I may first of all call attention to an external character of the little-known *Chamæleon calcarifer*. One of the external characters which distinguishes *Ch. calcarifer* from *Ch. vulgaris* is the presence in the former of a more distinct ventral crest composed of a line of conical and, at times, overlapping "enlarged granules." This line is traceable, but is by no means so well marked, in *Ch. vulgaris*. The division of these ventral scutes which marks the position of the umbilicus in the fœtus is therefore exceedingly obvious in *Ch. calcarifer* and less easily to be mapped out in *Ch. vulgaris*. It lies behind the middle line of the body. It is represented by a long space contained in the middle of the ventral crest, which bifurcates to embrace it, and in this region therefore is double. The number of scales on the two sides is uneven; I counted 13 on the left and 11 on the right side. The size of the region of the integument which appears to mark the umbilicus was rather greater in *Ch. vulgaris*, but, as already said, the indistinctness of the ventral crest renders it difficult to be accurate. In *Ch. dilepis* this area was quite as distinct as in *Ch. calcarifer* and occupied the same position; there were, however, only 10 pairs of scales, closely apposed.

The *lungs* show some variation in structure from species to species. That there is some variation in these organs has already been pointed out by Wiedersheim, who figures those of *Ch. vulgaris* and of *Ch. monachus*. The differences seem mainly to affect the number and form of the tags which are appended to the lungs, those very characteristic anangious outgrowths of the lung. Wiedersheim distinguishes between the more or less cylindrical outgrowths and the branches of the lung itself which bear them. The outgrowths, which exist more anteriorly and always on the ventral side of the lung, are simply the tubular cæca. Towards the end of the lung the lung itself is divided into several processes. In a young example the author quoted found that the cæca were solid. There is therefore reason for distinguishing the pulmonary cæca from the lungs, and a careful examination of both shows a ceasing of the reticular bands which cover even the anangious part of the lungs. As the number of outgrowths not

* Ber. naturf. Ges. Freiburg-i.-Br., Bd. i. 1886, Heft 3.

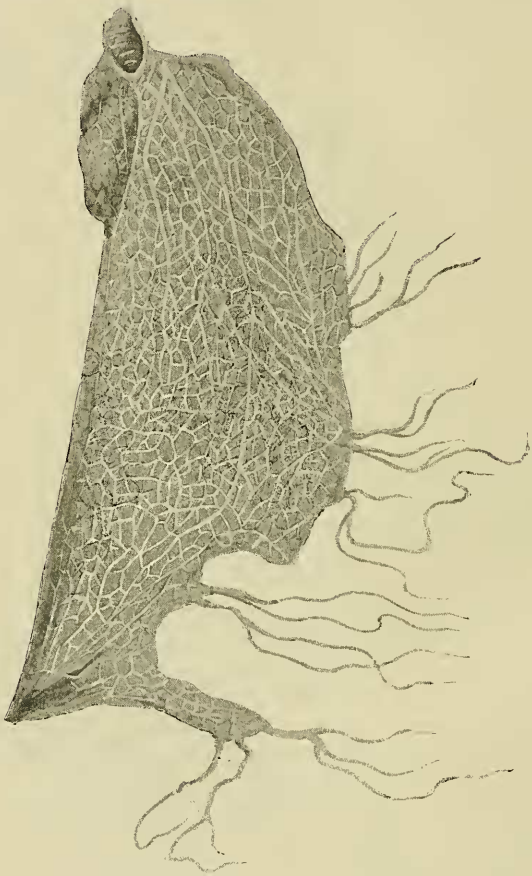
only varies in individuals, but also on the two sides of the body of the same specimen, their mere number and arrangement can hardly be utilised as distinctive of species without examining a large series. Yet I am disposed to think, for reasons that will be discussed later, that *Ch. monachus* does differ from *Ch. vulgaris*.

In *Chamæleon calcarifer* the lungs show the same general structure as do those of *Ch. vulgaris*. That is to say, the lung itself is frayed out into processes posteriorly. These again may or may not give rise to the tubular cæcal outgrowths. The latter show no network upon their surface, but the direction of the fibres of which they are partly composed is rather circular. On the ventral side also, some way in front of the end of the lung, the lung itself is prolonged into processes. I counted altogether in one lung examined fifteen tubular cæcal outgrowths. But as the numbers have been stated by Wiedersheim to vary in *Ch. vulgaris*, the exact number is probably not a matter of importance. They were, however, certainly more numerous than in an example of *Ch. vulgaris* which I have myself studied. What appears to be of importance is to note that the lung itself is divided and that the tubular outgrowths do not arise from a lung with an entire margin. The subdivisions of the cavity of the lung seem to be exactly as Wiedersheim has described for *Ch. vulgaris*. In *Ch. verrucosus* the tubular cæcal outgrowths are very numerous. I counted twenty-five or more of them. All the cæcal outgrowths were borne in four tufts, of which that furthest from the bronchus was the largest, and consisted also of an outgrowth of the lung itself. The individual tubular cæca were frequently to be seen arising by the division of a common stem (text-fig. 10, p. 38). The disposition of the cæca in this species is very different from that which I have observed in others.

The lungs of *Chamæleon dilepis* appear to differ in certain respects from those of the species that have been hitherto described. The obvious difference is the tubular character of the cæcal outgrowths, which have hardly any dilated termination, shown so plainly in *Ch. parvilobus*, for example (text-fig. 12, p. 39). In the second place, the tubular cæca are thick-walled and not at all transparent except in parts, and then not so transparent as in other species. Furthermore, these processes are distinctly shorter in *Ch. dilepis* than they are in *Ch. parvilobus*, as is indicated in the annexed figure (text-fig. 11, p. 39). The differences above set forth can hardly be due merely to a different state of contraction, since both specimens came out of the same bottle of alcohol in which they had been preserved some time since; and very well preserved, for there was no trace of softening or disintegration of the viscera. The cæca of *Ch. dilepis* are certainly to some extent contracted, as they can be pulled out without using undue force. There remains, however, a condition which differs from the attenuated and thin cæca of *Ch. parvilobus* and *Ch. verrucosus* on the one hand, and from the prolongation of lung-substance with shorter cæca in *Ch. calcarifer*, on the other. The marked distinctness of the cæca from the lung

is, in fact, a feature of this species as contrasted with those that have been mentioned. It will be observed in the figure (text-fig. 11) that the lung terminates in a cæcum which continues in the same straight line. This seems to be the case also with other species. It suggests, of course, the distal terminal air-sac (abdominal air-sac)

Text-fig. 10.

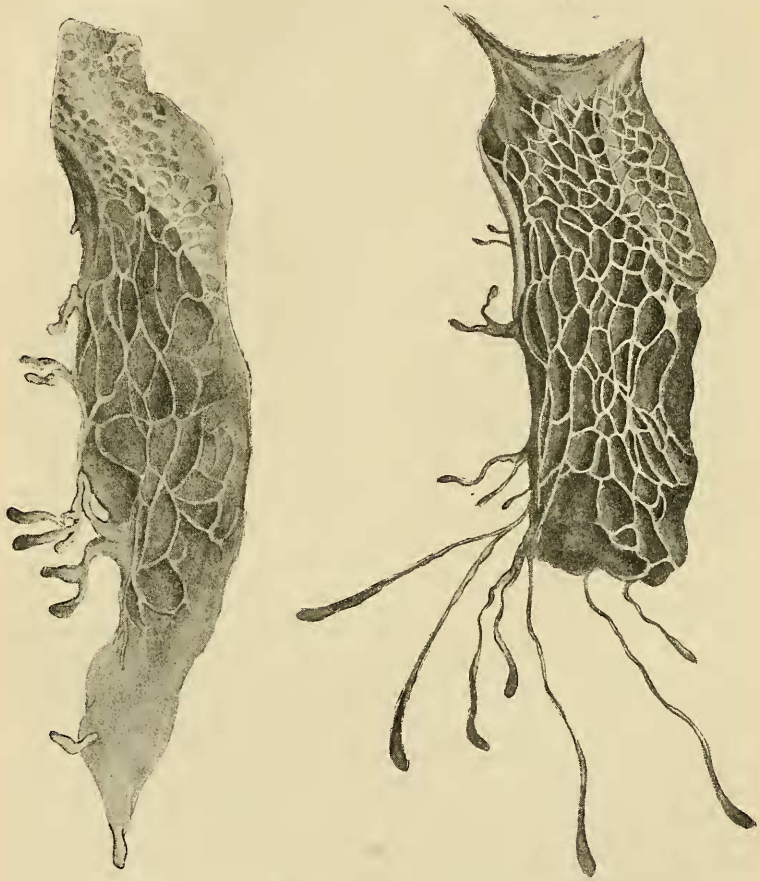


Lung of *Chamæleon verrucosus*, entire.

of the bird's lung. The arrangement of the other cæca is shown in the figure referred to. They are developed along a considerable region of the ventral margin of the lung. The larger number of the cæca are, however, massed at one spot, which is not at the end of the lung as in *Ch. parvilobus*, but at about its middle. Another

noteworthy difference about these cæca as compared with those of other species which I have examined, is that there is an anastomosis between the roots emerging separately from the lung. Finally, the small number of cæca as compared, for example, with *Ch. calcarifer* is a fact worthy of attention, since it is the beginning of the immense reduction seen in *Ch. basiliscus*, which culminates in the total absence of these cæca in *Ch. pumilus*.

Text-fig. 11. Text-fig. 12.



Text-fig. 11.—Lung of *Chamæleon dilepis*, entire.
Text-fig. 12.—Lung of *Chamæleon parvilobus*, opened longitudinally.

The above description also applies in generalities to the right lung of the same individual. That is to say, with regard to the shortness, tubular character, and fewness of the cæcal outgrowths.

A specimen which I had the opportunity of examining fresh showed how the lungs may vary in individuals, as was pointed out by Wiedersheim. This variation consists principally in the larger number of cæca. I should mention, however, first of all that there is just a shadow of a doubt as to the identity of the species. In the second smaller specimen the occipital lobes characteristic of the species were disproportionately smaller than in the larger individual, whose lungs I have already described. In the second place, the larger individual had no trace whatever of the "Hohlenvenenfortsatz" of the right lobe of the liver accompanying the postcaval vein. In the smaller individual there was a considerable process of hepatic tissue accompanying the postcaval vein for some distance.

In the case of both right and left lung, the lung ended, in the same way as in the example already described, in one bifid cæcum, bifid from the very first. In one lung I counted 14 other cæcal outgrowths, of which five were particularly short. In the other lung I found as many as 16 outgrowths, of which only three or four were short. Two, or even three, sometimes borne upon the same stem. The cæca are of considerable diameter and clubbed in form; they contrast markedly with those of *Ch. verrucosus*.

I have also selected for figuring the lung of *Ch. parvilobus* (text-fig. 12), which is at the very opposite extremity from the other species figured in the present communication, viz. *Ch. dilepis*. The cæca are numerous and extremely slender and in some cases of great length. Thus the longest measures 33 mm. as against 32 mm. of the length of the lung itself, and there are several other cæca nearly or quite as long. The longest of the diverticula are at the posterior end of the lung. The whole ventral border is also beset with diverticula, but these are invariably short; all show a marked dilatation at the free extremity. In contrasting these slender extended diverticula with the short thick diverticula of the two species *Ch. dilepis* and *Ch. basiliscus*, to be described immediately, one is disposed to believe that greater contractility in the case of the two latter may account for the great difference which they show from the species here under consideration; especially since Milani's figure* of the lung of *Ch. basiliscus* indicates long slender diverticula with slightly pronounced dilatations at their extremities.

Chamæleon basiliscus has lungs which have been described by Milani† and which agree most nearly perhaps with those of *Ch. dilepis*. The lung itself is extensive and reaches back nearly to the kidney. The specimen which I had the opportunity of examining had been preserved for some time in alcohol. In neither lung could I find any cæca depending from the ventral margin of the organ, and in the left lung I did not find more than a single cæcum at the posterior end of the lung, but conspicuous enough when detected by its yellow colour as contrasted with the colourless and transparent wall of the lung itself. In the

* Zool. Jahrb. (Abth. f. Anat.) vii. p. 577.
† *Loc. cit.* p. 576.

right lung, however, though there was a perfect agreement with the left lung in the absence of any ventral cæcal outgrowths, such as occur in other Chamæleons, there were three obvious cæca at posterior end. Milani figures five cæca. These were quite tubular and not swollen at the free extremity, as, for instance, in *Ch. parvilobus*. The walls are thick and they arise from a thick-walled portion of the lung. These cæca are, in fact, exactly like those of *Ch. dilepis*, from which the present species mainly differs in the extreme fewness of the cæca, as is apparent from Milani's figure.

Chamæleon pumilus has lungs which differ in several important points from those of the species that have been hitherto considered. In the first place, there are no signs whatever of any bronchi in the lungs. When the left lung is opened and the appearances presented compared with those to be seen in *Ch. vulgaris*, the following differences are recognisable. In both the aperture of communication between the two lungs, which represents, of course, the distal extremity of the bronchus, permits the interior of the right lung to be to some extent viewed. In the case of *Ch. vulgaris* the cartilaginous rings of the bronchus have to be cut up in order to display fully the aperture into the right lung through which are seen the cartilaginous rings of the bronchus of the right lung. In *Ch. pumilus*, when the lateral wall of the left lung is removed no trace whatever of any bronchus is seen; there is simply a large circular orifice putting the two lungs into communication, which shows no traces of any bronchial cartilages that can be detected by the unaided eye. It is not plain whether this condition is to be regarded as primitive or as evidence of degeneration. The lung itself is considerably shorter, relatively as well as actually, than in the species which has been dealt with in the preceding lines. It is, furthermore, different from the lungs of these other species in that the typical lung-structure persists throughout the whole sac. The alveoli in the lungs of Chamæleons generally are smaller and deeper proximally and get larger and shallower posteriorly, ultimately becoming practically invisible. The hinder region of the lung is anangious. In *Chamæleon pumilus* the alveoli become rather less marked posteriorly, but they are much more conspicuously circumscribed up to the very end of the lung than is the case with any of the larger species which I have had the opportunity of examining. The lung, in fact, is less metamorphosed into a mere air-sac in the present species than in any other which I have examined, excepting only *Ch. tæniobronchus*, to which species I shall have to refer again immediately. In this particular it is plain that the lung of *Ch. pumilus* is more typically Lacertilian than that of such a species as *Ch. vulgaris* or *Ch. calcarifer*.

A final peculiarity shown by the lung of this species is very remarkable. It has been stated in many general works that the Chamæleons as a family are to be characterised by the cæcal outgrowths of the lungs, which have been considered in several

species in the foregoing pages, and that is certainly the general impression among zoologists and anatomists. I was greatly surprised therefore to find that the lungs of *Ch. pumilus* are quite unprovided with these otherwise characteristic outgrowths. The margin of the lungs is entire and slightly sinuous, the convexities occurring in the sinuous line being perhaps to be looked upon as rudiments or incipia of the cæcal appendages. It will be observed that the absence of these cæca is associated with a more complete retention of the typical pulmonary structure of the lung, and therefore its greater efficiency as a breathing-organ. On the other hand, it is to be noted that where the cæcal tubes exist the lung itself has lost considerably the alveolate structure and thus presumably some of its efficiency as a breathing-organ. The Ophidia particularly show that the lung may be too large for its office as a respiratory organ, and they, like the Chamæleons, are often lethargic in habit.

The above account of the lungs of *Chamæleon pumilus* is, in so far as the absence of tags is concerned, in harmony with the description of both Meckel* and Cuvier†. The latter observes: "Le *Caméléon nain* n'a rien de pareil; ses poumons sont deux petits sacs simples, ovales, de grandeur égale, comme ceux de la plupart des Sauriens"; and on another page: "Ils manquent d'appendices." Milani, however, obviously doubts these statements in writing‡ as he does: "Ob bei *Chamæleon pumilus* die Zipfel wirklich fehlen, oder ob diese Behauptung nicht vielleicht auf ein mangelhaftes Präparat zurückzuführen ist, wage ich hier nicht zu entscheiden." It is because of the latter doubt cast upon the facts that I have entered into the matter at some length, and, as I hope, settled it.

I have finally to add to the description of the lungs in various Chamæleons that *Ch. tæniobronchus* agrees entirely with *Ch. pumilus* in the total absence of diverticula, an agreement which is very significant in view of other facts.

The *pigmentation of the interior of the body* varies among the species of this genus. In all that I have examined the intestinal tract is a deep black, and there are generally (but not in *Ch. verrucosus*) patches of pigment upon the stomach not distributed so universally. The mesenteron is largely pigmented anteriorly in *Ch. verrucosus*. There is no variation, however, in the pigmentation of the gut. The parietal walls are not so generally pigmented. It is, indeed, only in *Ch. pumilus* and in *Ch. tæniobronchus*, among the species which I have examined, that the whole of the lining peritoneum of the body is of a deep black, quite as deep as is the gut. This pigmentation also extends to the mesenteries. In all of the remaining species the pigmentation of the general body-cavity and the mesenteries is hardly to be seen and only exists in very slight degree, so as not to affect the

* "Respirationsystem der Reptilien," Deutsch. Arch. f. d. Phys. 1818.
† Leçons d'Anat. Comp. 2me éd. par Duvernoy, t. vii. (Paris, 1840).
‡ Zool. Jahrb. (Abth. f. Anat.) vii. p. 573, footnote.

general appearance. This peculiarity at once divides the two species mentioned from the rest, and other anatomical peculiarities described in the present communication tend to show the separateness of these two Chamæleons from others.

It may be remarked that the table of external characters used by Boulenger in the discrimination of the species of the genus brings together *Ch. pumilus* and *Ch. tæniobronchus* *.

Pancreas.—The shape of this organ shows differences in the species of *Chamæleon* which I have examined. In all it lies partly between the stomach and the recurrent loop of the duodenum, and partly dorsal of the stomach and to the posterior side of that organ. That is to say, when the reptile is dissected and viewed in the ordinary position lying on the right side part of the pancreas, that lying between the stomach and the duodenum is visible and the rest is seen when the stomach is raised. The main differences in form are the relative thickness of the gland and the relations of the splenic lobe, which here, as in other Lizards, is to be distinguished at least to some extent from the rest of the gland. The distinction between the two lobes of the pancreas is most plainly to be observed in *Ch. dilepis*, where the splenic lobe is quite at right angles with the rest of the gland, and the duodenal part is continued on for a very short distance before it gives off the splenic lobe. In all the remaining species there is no such marked distinction, the two lobes forming one curved elongated mass. This is particularly plain in *Ch. tæniobronchus*, where the coils of the intestine lie entirely behind the pylorus, and the pancreas is therefore exposed for its whole length and not partially hidden by the stomach. I shall recur later to the coiling of the intestine in this and other species of *Chamæleon*.

The bulk of the gland differs greatly in the several species. In some it is much thinner than in others, and therefore, as the length is not far from being the same, relatively as to the size of the species the actual bulk fluctuates. Two extremes are well seen in the two species *Ch. dilepis* and *Ch. calcarifer*, which, on account of their practically identical size, show the facts very plainly. In *Ch. dilepis* the gland is very thick, quite as thick as the diameter of the adjacent pyloric region of the stomach; its greatest diameter is about 6 mm. On the other hand, in *Ch. calcarifer* the pancreas is comparatively quite excessively slender, and only measures 3 mm. or so in transverse diameter in the region which lies ventrally and in front of the stomach. There are similar differences between other species; but I do not give details, as the individual species vary so much in size that a comparison of the glands would involve rather complex measurements; these would be of more value if the number of individuals examined were large. The prominent and easily recognisable differences between the two species selected will serve as an example of what also occurs elsewhere in the genus. There are, however, too great a series of

* Cat. Lizards Brit. Mus. vol. iii. 1887, p. 440.

gradations between the extremes to permit of the use in classification of the dimensions of this gland.

Liver-lobes.—The proportions of the two lobes of the liver* differ markedly in several species of the Chamæleons reported upon in the present communication. Thus in *Ch. pumilus* the right and left lobes are so nearly equal that only one can be seen with just traces of the other when the viscera are viewed from the left side. The gall-bladder is partly covered by the extensive left lobe, which, moreover, comes into contact with the stomach.

The most extremely opposite conditions to these are shown (so far as the material in my hands enables me to say) in *Ch. calcarifer*. In that Chamæleon the left liver-lobe is very much shorter than the right. When the animal is viewed in the same posture as the last, the left lobe leaves exposed a section of the right lobe as long as itself, and does not even reach the gall-bladder, which lies on the right lobe not very far from its tip. There is, of course, no contact between the left lobe of the liver and the stomach, the ventrally flexed region of which lies considerably behind the end of even the right liver-lobe.

In *Ch. basiliscus* the viscera in question are arranged and have very much the same proportions as in *Ch. calcarifer*. The same may also be said of the Common Chamæleon (*Ch. vulgaris*) and of *Ch. verrucosus*†. In *Ch. parvilobus* the two lobes of the liver are approximately equal, and the left lobe completely conceals the gall-bladder when that viscus is viewed from the left side. On the other hand, it, the left lobe, does not come so near to the stomach as in *Ch. pumilus*. Very much the same description will serve for *Ch. dilepis*, save for the fact that in this Chamæleon the gall-bladder is not so completely hidden by the left lobe as in *Ch. parvilobus* and *Ch. pumilus*. The characters of the liver, therefore, hardly allow of any grouping of the species; for there are gradations. The *alimentary canal* does, however, show certain differences which permit of a grouping such as has been already suggested.

In *Ch. calcarifer* and the other larger species the intestine is as well coiled as in other Lacertilia, and when the animal is opened from the side a good deal of the small intestine is seen to lie in a coil with secondary convolutions in front of, *i. e.* headward of, the pyloric end of the stomach. The stomach, in fact, partly covers a section of the small intestine when the viscera are viewed from the left side. In *Ch. pumilus* there is only one short bend of duodenum, which lies in front of the stomach. But the opposite extreme to *Ch. calcarifer* is to be seen in *Ch. tæniobronchus*. In this small Chamæleon the end of the stomach is not bent upon itself at all, but is continued back in a straight line to join the intestine, which is but little coiled upon itself. Moreover, the whole length of the intestine lies completely behind the stomach.

* The liver itself is very compact in these reptiles, unlobulated, and with very firm outlines.

† I could see no gall-bladder in this species.

There is thus a simplification in the coiling of the gut in this very small species which is not so strongly marked in the rather larger but still small *Ch. pumilus*. It is not without interest to note this apparent relation between smallness of size and simplification of structure shown also in the lungs of these species, as has been already commented upon *.

(2) *Some Notes upon* Chamæleolis.

This Lizard is placed among the Iguanidæ in spite of its superficial likeness to a Chamæleon. Indeed this superficial likeness is not after all very striking, and depends mainly upon the fact that the head is prolonged behind and above into a parietal crest. Nevertheless it is of advantage to be able to record a few facts in the visceral anatomy which distinctly confirm the placing of this genus in the immediate neighbourhood of *Iguana*. It has, moreover, its own peculiarities as compared with that genus; and therefore as a contribution to the visceral anatomy of the Lacertilia I am laying before the Society such facts as I have gathered from a dissection of a female individual. The existing knowledge of the anatomy of the Lacertilia shows that there are four marked structural features in which all the Iguanidæ that have been examined agree with each other, and the combination of which allows them to be defined. I shall, therefore, first of all deal with these four points, which together prove that *Chamæleolis* has been rightly placed among those Lizards.

In the first place, the umbilical ligament which divides the two liver-lobes and is attached to the ventral median line of the body is a single ligament which runs continuously from end to end of the liver, without any trace of a posterior division upon the liver, as I have lately figured in *Iguana* †. The gall-bladder is left to the right of this ligament. In these particulars the umbilical ligament of *Chamæleolis* is precisely like that of *Iguana*, and there is no need to illustrate the relations of the ligament by a figure. I may mention that it is deeply pigmented.

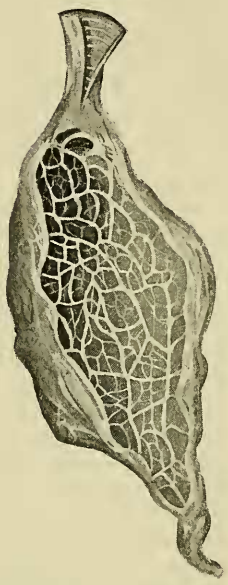
A second feature, which, though a small character, appears to be a constant one, is the position of the intercostal arteries in relation to the vertebræ. In *Chamæleolis*, as in some other Iguanoids, these arteries plunge into the thickness of the dorsal parietes towards the posterior end of each vertebra; in some other Lizards they disappear from view at about the middle of each vertebra. Of course, *Chamæleolis* has the same regular arrangement of pairs of these arteries as in other Lizards, a feature, indeed, which seems to differentiate the Lacertilia from the Snakes, at least broadly considered.

Thirdly, Milani ‡, whose account of the Lacertilian lungs is the most recent and comprehensive known to me, has found that in the Iguanidæ the lung is totally divided into two chambers, of

* *Supra*, pp. 39 & 41.
† P. Z. S. 1905, vol. i. p. 12, fig. 7.
‡ Zool. Jahrb. (Abth. f. Anat.) vii. p. 545.

which the more dorsal extends headwards of the orifice of the bronchus. This statement at any rate holds good for the majority of the Iguanidæ that have been examined. *Chamæleolis* does not agree with these types, for the lung is not divided by an obliquely placed septum into two approximately parallel chambers. It is, nevertheless, not to be removed from the Iguanidæ on this account, since it appears to present points of likeness to the undoubtedly Squamoid *Phrynosoma*, and one point at least of resemblance to the Iguanoid genus *Polychrus*.

Text-fig. 13.



Lung of *Chamæleolis*, opened longitudinally.

The bronchus enters for a short distance into the lung as a completely circular tube; there is no snake-like series of flattened semirings such as is to be found in *Iguana**. The projecting bronchus is, as in *Phrynosoma*, moored to the walls of the lung by septa. The cavity of the lung, therefore, extends headwards of the opening of the bronchus and all round it. There is no septum in either lung which separates off the dorsally placed cæcum of the lung as a distinct cavity from the rest of the cavity of the organ. In the left lung the structure happened to be more favourable for observation than the right lung, and I have accordingly had a drawing prepared (text-fig. 13) of the interior of this lung. It

* Milani, *loc. cit.* pl. xxxi. fig. 13.

will be there seen that the strong septa which produce a pouching of the dorsal region of the lung in other Iguanids and Agamids are also to be seen in *Chamæleolis*. I observed six of the chambers altogether, of which three would appear to belong to the anterior part of the lung, *i. e.*, that region which is in other Iguanids divided off by a septum from the posterior region, and three larger pouches belonging to the posterior region of the lung. Finally, the end of the lung abruptly narrows and forms a finger-shaped region with a but slightly marked network. It seems to me to be possible to compare this with the Chamæleon-like outgrowths of the lung in *Polychrus marmoratus* *.

In the fourth place, the right extremity of the liver is attached by a fold of membrane which separates the lung from the post-hepatic region of the body-cavity and is continuous with the oviducal membrane.

Besides these points, which, together with various external and osteological characters used by others, fix the systematic position of *Chamæleolis*, there are other features in its anatomy which I have ascertained and which are worth noting as a contribution to Lacertilian structure.

The pigmentation of the body-cavity is in some ways remarkable. The umbilical ligament, not only the region which is attached to the liver, but that which is attached to the stomach, is deep black, and in the latter region contrasts with the yellowish gut. The gut itself is, however, pigmented in the case of the large intestine. This pigmentation is limited to the dorsal side of the gut and involves the whole of the cæcum. The appearance presented is, indeed, of two tubes closely applied, of which one is the small intestine and the other ends at the blind extremity of the cæcum.

As in many Lacertilia, the peritoneum generally is deeply pigmented, and a distinction is to be drawn between the posterior pigmented region and the anterior region of the body-cavity, where its walls are not pigmented at all, so far as naked-eye appearances go.

While, however, in most Lacertilia this line of demarcation is quite oblique, bending ventrally in a continuous curve, it is in *Chamæleolis* quite transverse (to the longitudinal axis of the body) in direction, but with a curved outline, now convex, now concave.

The existence of bundles of plain muscular fibres in the mesenteries reaches a very great degree of development in many Lacertilia. In the Lizard which forms the subject of the present communication there was no development of such fibres that could be seen with the unaided eye. The ovaries contained no mature ova. There was a fully formed egg in each oviduct, with a dirty white shell of leathery consistency. There was no trace of an embryo in the egg.

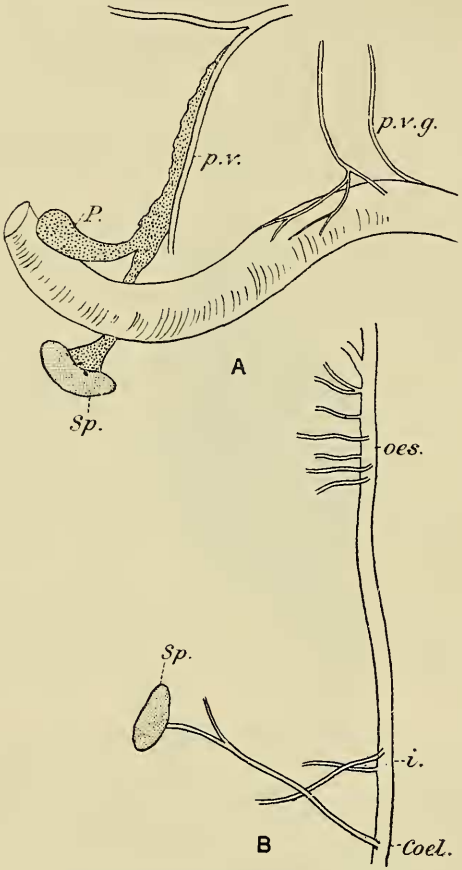
The apex of the heart is fixed to the pericardium by a very

* Milani, *loc. cit.* pl. xxxi. fig. 15.

slender gubernaculum cordis, a structure which is rarely absent from the heart of the Lacertilia *.

The arterial system presents certain peculiarities as compared with that of other Lacertilia. The disposition of the intercostal

Text-fig. 14.



A. Stomach and pancreas of *Chamæleolis*.
P. Pancreas; *p.v.* Portal vein; *p.v.g.* Gastric portals; *Sp.* Spleen.

B. Dorsal aorta and branches of the same.
Cœl. Cœliac artery; *i.* Intestinal arteries; *œs.* Œsophageal arteries; *Sp.* Spleen.

arteries has already been mentioned as a point of affinity with the Iguanidæ. The visceral arteries (text-fig. 14) which supply the

* But is absent in *Varanus* occasionally (see Beddard, P. Z. S. 1906, vol. ii. p. 617 footnote) and *Zonurus giganteus* (*infra*, p. 55).

alimentary canal are collected into two groups, leaving a tract of considerable length from which no arteries to the gut arise. The anterior group is situated just behind the union of the two aortic arches, and consists of no less than seven small arteries supplying the œsophagus and stomach. These arise from both sides of the aorta and are partly arranged in pairs; they run to both sides of the stomach. There is then a long gap until the origin of the intestinal arteries. The general plan of these is like that in most Lacertilia; but there are differences in detail from those of many genera. When the mesentery is turned over to the right the cæcal artery which arises most anteriorly is seen to run over the following duodenal artery, but under the third artery, that which supplies the spleen, &c.

With regard to the venous system, the only notes that I have made refer to the hepatic portal system. The junction of the anterior abdominal and the main portal trunk is very near to the conjoint entrance of both into the liver—much nearer than is the case with many Lizards. In addition to this, the chief portal trunk, there are two vessels which pour blood direct from the stomach into the liver (text-fig. 14): one of these, the more posterior in position and the larger, is associated with the left lobe; the other, a slender twig, enters the liver to the right of the last described. The ventral parietal hepatics are also two, of which one is a little to the right of the other in its point of entrance to the liver. Both are rather far forward on the liver. There is but one dorsal parieto-hepatic. This, as is the case with other Lizards*, is associated with the "Hohlvenenfortsatz" of the liver, and runs in the mesentery, binding that lobe of the liver to the right parietes. It runs a considerable way forwards along the vertebral column before becoming lost in the thickness of the parietes.

The *pancreas* of *Chamæleolis* (text-fig. 14) is constructed upon the usual Lacertilian plan, but differs in various details from that of other Lizards. It is a Y-shaped gland and completely solid throughout. There are no thin diffuse branches spread through the mesentery such as are to be found in the case of the pancreas of *Zonurus giganteus*†. One arm of the Y ends, after dilating slightly, in the concavity of the somewhat bean-shaped spleen; the other forms a thick mass in contact with the commencement of the duodenum. The stem of the Y forms a thin rod of pancreatic tissue, which closely accompanies the portal vein and very nearly touches the liver. This region of the pancreas seems to me to be longer than in some other Lacertilia, though in most there is a process of the pancreas running in the same direction. The splenic lobe of the pancreas is not extraordinarily thin, as it is in *Tiliqua scincoides*‡, but of fairly robust diameter.

* The absence of this vessel is rare, but Hochstetter, whom I have been able to confirm, has asserted its absence in *Chamæleon vulgaris*. I take this opportunity of stating that this vein is also absent in *Chamæleon verrucosus*.

† *Vide infra*, p. 55.

‡ See Beddard, P. Z. S. 1905, vol. ii. p. 262.

(3) *The Position of the Umbilicus in certain Vipers.*

I am not aware that the point of entrance of the umbilical sac into the body in Snakes has ever been made use of as a systematic character. I find, however, from a few observations that I have been able to make recently, that this anatomical relationship is apparently of systematic value. Since of one species, viz. *Lachesis lanceolatus*, selected for these observations, I have been able to examine a considerable number of individuals, the variation of the character from one individual to another became a matter of additional interest, especially in view of the fact that all the individuals were of one brood. It appears that in Vipers, as compared at any rate with the Anaconda*, the umbilicus is much nearer to the cloacal aperture. I have examined fourteen individuals of *Lachesis lanceolatus* of the same brood and of approximately the same size, though they died on different dates, from March the 9th to May. The length varied from $11\frac{1}{2}$ to 12 inches exclusive of the short tail. I do not give measurements in millimetres, since to use such gives an appearance of rigid accuracy not attainable in a dead snake capable of artificial extension and shortening. In nearly all of these fourteen individuals four scales occupied the umbilical region, each of them being bisected by a groove running longitudinally to the axis of the body. I found, in fact, that there were four scales thus modified in eleven individuals. In two of the remaining snakes there were five of these scales in which the two sides had not joined across the middle ventral line, and in the fourteenth individual only three scales and a portion of the fourth; the number of scales intervening between the last of the "umbilical" scales and the anal scale varied a good deal but within very narrow limits. The actual facts are these: in three specimens 17 scales intervened between the points mentioned; in one specimen 18 scales; in five others 19 scales; in three 20 scales; in one 21 scales; and, finally, in one 22 scales. The average is thus arithmetically 19, and actually there were more specimens exhibiting the average than any other number. Having due regard to the narrow range of the variation, it seems likely that the position of the umbilicus in this species of Viper can be regarded with safety as lying 19 scales in front of the anal scale. It is important to notice the length of time during which this fœtal character is retained. The last specimens examined by myself died on May 15th of last year. These and the other individuals were acquired by the Society on Dec. 12th, 1905. The last specimens examined by me were therefore more than six months old. I have some confidence, therefore, in comparing *Lachesis lanceolatus* in respect of these characters with other Vipers of an obviously greater age. I may first of all, however, refer to newly-born Vipers which I have recently dealt with † in

* See Beddard, P. Z. S. 1906, vol. i. p. 13.
† P. Z. S. 1906, vol. i. p. 34.

a paper communicated to this Society. It is impossible to be certain of the exact position of the actual umbilicus in *Lachesis lanceolatus* for the purposes of comparison between these two types, *i. e.*, which of the four or five broken scales correspond to the two scales in *Bitis nasicornis* which are actually divided by the fœtal blood-vessels. Assuming, however, that they are even the last two, there still remains a substantial difference in position between the umbilicus of the two species. For in *Bitis nasicornis* the actual numbers of scales intervening between the umbilicus and the anal scale are respectively in the five examples studied 9, 11, 11, 12, 14. There is thus exactly the same amount of variation as in *Lachesis lanceolatus*, but round a different mean.

The position of the umbilicus in Russell's Viper (*Vipera russellii*) is again different and relatively more fixed than in either of the species hitherto considered. As in *Bitis nasicornis*, the actual umbilicus consists of two scales only, which do not meet ventrally, and between which the plug of tissue bearing the umbilical vein &c. passes into the interior of the body. The young Vipers in question were a very few days old, but all external traces of the yolk-sac had disappeared. In front of these two scales either two or three scales were divided by a suture in the middle ventral line, and posteriorly to the two "umbilical scales" either one or two scales were similarly split by a ventral suture. Between the last of the two completely divided scales and the anal scale there intervene in the five examples examined respectively 16, 16, 16, 17, 17 scales. The position of the umbilicus is therefore different in this Viper, and its fluctuations of position are less than in the two species to which I have already called attention. It is perhaps permissible to call attention to the fact that *Vipera* and *Lachesis* agree with one another more nearly than either does with *Bitis*. This is, of course, not in accord with generally received views upon the classification of Vipers.

I have examined several Vipers of more mature age, and in two specimens, at any rate, I find what appear to be obvious traces of the umbilicus. In a not fully-grown example of *Bitis arietans* measuring 30 inches from the snout to the cloaca, four scales showed a line of division in the ventral median line. The second of these had the most strongly marked groove, and possibly therefore represents one of the two scales already described in the young as immediately surrounding the stalk of the yolk-sac. Between the last of the grooved scales and the anal scale 9 scales intervened. The species evidently therefore comes nearest to the other species of *Bitis* which has been described above. In a second specimen measuring 32 inches there were 12 scales between the last of four grooved scales and the anal scale. I have also seen similar traces in a large adult example of *Bitis gabonica*. Here there were also four scales showing traces of the umbilicus; but instead of being grooved they were merely nicked posteriorly. Between the last of them and the anal scale 8 scales intervened

It is not safe upon these two last-mentioned examples to attempt to draw any distinctions between the different species of *Bitis*. It seems, however, to be most probable that they do not differ widely from each other as regards the points under discussion, whether they will ultimately be found to differ specifically or not. It is, however, quite plain, in reviewing all the facts brought forward in the present communication, that the position of the umbilicus among Vipers is one that does at least characterise some forms which happen in the instances studied to be generically separated.

(4) *Some Notes upon the Anatomy of* Zonurus, *with Special Reference to the Hyoid.*

The following notes refer to three specimens of *Zonurus giganteus* which I have had the opportunity of dissecting during the last year or two. The anatomy of this Lizard is already to some extent known through the work of previous observers. The lungs have been dealt with by Milani * in his general account of these organs among the Lacertilia, and the arteries of the gastric and intestinal regions are described and figured by Hochstetter †. There remain, however, a few points to which it is worth while calling attention as a further contribution to the natural history of this Lacertilian.

Of special importance—rather, however, from a general point of view than as a particular contribution to our knowledge of this Lizard—is the condition of the elements which together make up the hyoid complex of bones and cartilages in this Lacertilian. I am able to add to what I have to say concerning *Zonurus* a few notes upon other genera of Lacertilia which I have dissected for purposes of comparison. I commence with a brief *résumé* of some of the facts already known of this part of the skeleton.

The hyoid and branchial arches of Lacertilia have not, as it appears, been investigated in a very large number of genera. Several are figured in the volume ‡ of Bronn's 'Thierreich' dealing with the Lacertilia, while other genera have been illustrated by subsequent writers §. Apart from differences in the form of the individual elements of the hyoid complex there is substantial agreement, according to these various writers. For contrary to what is to be found in the Chelonia—where the remains of the hyoid arch proper is followed by two branchial bars considerably developed—the Lacertilia are generally believed to be characterised by the preservation in the adult of only one visceral arch following the hyoid arch, which is stated to be the first branchial. This statement occurs at any rate in such authoritative textbooks

* Zool. Jahrb. (Abth. f. Anat.) vii. p. 545.

† Morph. Jahrb. xxvi.

‡ Reptilia, Bd. vi. Abth. iii. Taf. 72. figs. 2–8, & Taf. 107. figs. 24, 33.

§ E. g., *Gecko mauritanicus*, Gadow, Phil. Trans. 1888 B, pl. 72. fig. 10; *Heloderma suspectum*, Shufeldt, P. Z. S. 1890, pl. xviii. fig. 6; *Chlamydosaurus* and *Physignathus*, Beddard, P. Z. S. 1905, vol. i. p. 20, text-fig. 9, and p. 21, text-fig. 10.

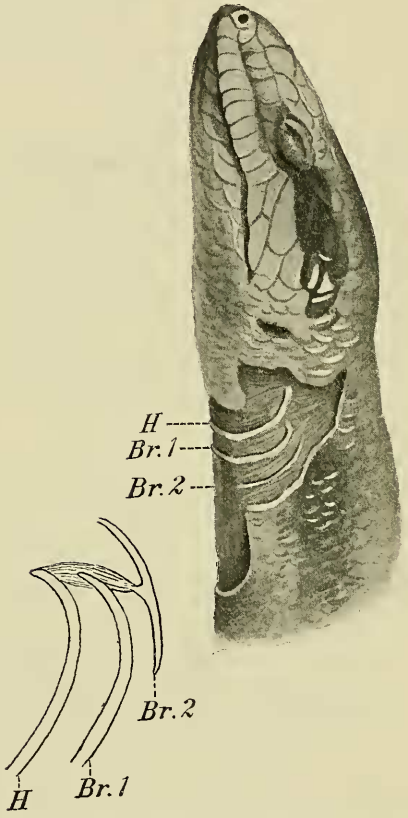
as those of Hatchett Jackson *, Gadow †, and Sedgwick ‡, which may be regarded as expressing the current knowledge of the subject. Nevertheless, the late Prof. W. K. Parker §, in describing the *adult* skull of *Lacerta agilis*, wrote as follows:—"Another bar, half as long as the first, and unossified, lies behind the first branchial above; it is *f*-shaped, with the top hooked inwards, like the lower piece; this is the upper (*br.*^{2}), or 'epibranchial' part; it has a small snag outside its middle. Besides this, there is, on each side, a slender, slightly outbent hypo-branchial (*h.br.*); this belongs to the second branchial, and also from its length is evidently part of the *third*, neither of which chondrify, above, in the embryo." In a footnote is added the remark that "this little highly-metamorphosed Lizard has scarcely thrown aside the skeleton of these organs of aquatic respiration." It is obvious that Prof. Parker's account is a little misleading, and this doubtless accounts for the fact that the existence of remains of a second branchial arch in *Lacerta* has been largely ignored in zoological literature. What he speaks of as an "epibranchial," without determining to which arch it belongs, but letters "*br.*^{2}," is clearly from its position a vestige of the second branchial arch, as is plainly recognised in Prof. T. J. Parker's 'Zootomy' and in his 'Textbook of Zoology,' written in conjunction with Prof. Haswell ‖. The exceptional character of the hyoid complex of *Lacerta* in possessing "the epibranchial of the second branchial arch" is properly emphasised by Dr. Shufeldt ¶ in reviewing existing knowledge of the Lacertilian hyoid bones.

The third postmandibular arch is, however, by no means a peculiarity restricted to *Lacerta*. It occurs in *Zonurus* in the form of a short and slender bar lying behind the well-developed first branchial bar **. This bar of cartilage does not extend down to the median copula, and indeed falls a considerable distance short of it. I have examined three other Lacertilians in which this same visceral arch is represented and one in which it is not to be found; but I have not at present attempted an exhaustive research into the facts of its absence or presence among the different families of Lacertilia. I could not detect the bar of cartilage in *Chamæleolis*, whose anatomy has been described above. It is well developed in both *Tiliqua* and *Trachydosaurus*. In the former (text-fig. 15, p. 54) it is very conspicuous, and it is not a little surprising that it has been missed, unless I have unwittingly overlooked its description somewhere. But if this be the case it is clear that its existence has escaped the writers of many textbooks.

* 2nd ed. of Rolleston's 'Forms of Animal Life.'
† "Amphibia and Reptilia," in 'Cambridge Natural History.'
‡ 'Textbook of Zoology,' vol. ii.
§ "Development of Skull in Lacertilia," Phil. Trans. 1879, p. 616.
‖ 'Textbook of Zoology,' vol. ii.
¶ P. Z. S. 1890, p. 225.
** There is no trace of this shown in a figure of the hyoid of *Zonurus cordylus* copied from Henle in Bronn's 'Thierreich,' Reptilien, vol. vi. Abth. iii. Taf. 107. fig. 33.

In *Tiliqua* this second branchial arch is more extensive, as it appears, than in *Zonurus*, and lies obliquely across the first branchial arch, though beneath it. The latter arch ends in a curled piece of cartilage which is directed backwards and overlaps the third post-mandibular arch. But the position varies according to the degree of distortion of the muscles of the neck of the reptile.

Text-fig. 15.



Tiliqua scincoides, head and neck.
Dissected to show three postmandibular visceral arches *in situ*.
To the left the isolated extremities of the same arches in another individual.

Br. 1. First branchial arch; *Br.* 2. Second branchial arch; *H*. Hyoid arch.

Towards the lower end of the bar is a triangular, projecting, "snag" (not visible in one of two examples dissected) like that which Prof. W. K. Parker has figured in *Lacerta*. To this projecting process is fixed a ligament which is inserted on the free dorsal end

of the hyoid arch. The ligament thus avoids the first branchial under which it lies. It is not surprising to find that *Trachydosaurus*, so closely allied to *Tiliqua*, also possesses this second branchial arch. As in the genera mentioned, the arch is only represented by its upper part, the epibranchial, as Parker termed the equivalent cartilage in *Lacerta*. Finally, I have to record that the bar of cartilage is also found in *Gerrhonotus*, a genus of whose anatomy I offer some further notes below. In the present state of our knowledge it is not possible to state whether or not this occurrence does or does not bear upon the affinities of *Gerrhonotus*. The cartilage was not so easy to find in this small Lizard, where it is slender and delicate, but can be detected by gently moving in various directions the muscles in its vicinity; the stiff ends of the cartilage thus become apparent.

A second feature in the anatomy of *Zonurus* to which I desire to draw attention is the total absence of the gubernaculum fixing the apex of the ventricle to the walls of the pericardium. This ligamentous band or thread (it varies in importance in different genera) is so usual among the Lacertilia as to be characteristic of that order of Reptiles, as it is, indeed, of others. I have already pointed out that the gubernaculum cordis is not to be found in the heart of *Varanus niloticus* and some other species*. It is interesting to notice that this absence of the gubernaculum which is universal in the higher Vertebrates (Aves and Mammalia), as well as generally in the Ophidia †, is sporadically developed among the Lacertilia. It should also be mentioned that this condition of the heart was found in two examples of *Zonurus giganteus* (the third was not examined *ad hoc*)‡; it is therefore probably characteristic of the species if not of the genus.

The *liver* of this Lizard is unusual in its form. The right lobe is prolonged in the usual way over the vena cava. But the left lobe, instead of being but slightly divided at the entry of the anterior abdominal vein, is deeply bifid thereat §. The whole organ is thus markedly trifid posteriorly and is not unsuggestive, in appearance, of the mammalian liver.

The *pancreas* displays one noteworthy character. Its general form is like that of the majority of Lacertilia. The organ embraces the stomach, being found on both sides of it; the splenic lobe is fairly stout and reaches the spleen, and there is a process of the gland extending towards the liver. The peculiarity of the pancreas of this Lizard is that diffuse thin ramifying tags of pancreatic tissue lie in the mesentery on either side of the splenic lobe of the gland with which they are connected. This tendency towards a diffuse irregularly shaped thin pancreas is obviously to be compared with the conditions obtaining in the Chelonia.

* P. Z. S. 1906, vol. ii. p. 617 footnote.

† Perhaps universally also. In any case the occasional ligament tying the apex of the heart to the pericardium is rather different (see P. Z. S. 1904, vol. ii. p. 107).

‡ I have since found the same absence of the ligament in another example.

§ I am not quite certain that it is not the right lobe which is thus bifid. It is a point difficult to settle.

(5) *Some new Facts bearing upon the Affinities of* Gerrhonotus.

This genus of Lacertilia is sometimes placed in a special family of Lacertilia, the Gerrhonotidæ. By others (*e. g.*, Boulenger *, Gadow †) it is relegated to the Anguidæ. The general aspect of *Gerrhonotus cæruleus* is, on the other hand, by no means unlike that of the Scincidæ; I am not aware that any notes have ever been published upon the visceral anatomy of this Lizard. I venture, therefore, to lay before the Society some notes which a recent dissection of more than one example of *Gerrhonotus cæruleus* enables me to offer as a contribution towards the determination of the systematic position of this genus or representative of a family.

I have by no means attempted an exhaustive survey of the anatomy of this Lizard. But I am able to note down a few facts, all of which are of some interest from the point of view of a comparison with other Lacertilia. The structure of the *quadrato-jugal ligament* is one of the characters which I carefully examined in *Gerrhonotus*. I find that the arrangement and appearance of this ligament is precisely as it is in the genus *Gerrhosaurus* and in the Skink *Eumeces* ‡. That is to say, the ligament of this genus is very distinctly marked off and of equal breadth throughout, nowhere vaguely shading off into surrounding tissues. Moreover, it is attached on the one hand, of course, to the quadrate bone and on the other to the bony scales which cover the face in this region. It is not inserted on to any bone of the skull. In the present state of our knowledge it is not possible to comment upon this likeness to *Gerrhosaurus* and *Eumeces* as an argument in favour of the Skinkoid affinities of *Gerrhonotus*, though I have thought it worth while to record the fact for future comparison. The second feature in the structure to which I draw attention is the complete pigmentation of the interior of the body. There is here no paler area divided by the oviducal mesentery from a more darkly pigmented posterior portion.

As is now well known §, the umbilical ligament of the Skinks is frequently a double ligament attached to the ventral surface of the liver along two parallel lines which become confluent anteriorly. I observed nothing of the kind in *Gerrhonotus*, where the umbilical ligament is, as in most Lizards, a single mesentery. In this anatomical fact there is a likeness to *Ophiosaurus* as well as, of course, to *Iguana* and other Lizards. In any case the Lizard shows no affinities to the Scincidæ.

The pancreas and the spleen and their relationship to one another differ greatly among the Lacertilia, and more than one fact in the structure of the two glands is recorded in the present

* Catalogue of Lizards in the Collection of the British Museum.
† "Reptilia," in 'Cambridge Natural History,' p. 538.
‡ P. Z. S. 1905, vol. ii. p. 256.
§ Beddard, P. Z. S. 1888, p. 102.

communication *. In *Gerrhonotus* the splenic prolongation of the pancreas is present, but it does not reach the spleen at all, though extending a good way in the direction of that organ. Among the Skinks this pancreatic process towards the spleen is to be found, as I have already recorded †, in the genus *Tiliqua*, and can confirm in all details from a subsequently examined example of that genus.

There is, however, no particular likeness in the structure of the pancreas of *Gerrhonotus* to that of *Ophisaurus* ‡. In the latter the pancreas consists only of two closely applied lobes which rest upon the ventral surface of the pylorus and small intestine, there is no vestige of a splenic lobe §. The spleen of *Gerrhonotus* is rather peculiar in position. Very generally among the Lacertilia this blood-gland is elongated and somewhat bean-shaped in outline, and lies with its long axis parallel with the long axis of the stomach. In *Gerrhonotus* the shape is quite normal, but the long axis is perpendicular to the long axis of the stomach.

The hepatic portal system of veins of *Gerrhonotus cæruleus* varied but little in the two specimens dissected. The ventral parieto-hepatic veins running in the umbilical ligament were three in each Lizard. The first two crossed each in their course in one specimen, and perhaps in both, though I have no note as to this in the second example dissected. The crossing is such that the anterior of the two vessels draws blood from a region of the ventral body behind that which is supplied by the posterior of the two veins.

The dorsal parieto-hepatics are either two or three and are otherwise quite normal in their position. The arrangement of the gastro-hepatic veins is interesting in relation to the question of the affinities of the genus *Gerrhonotus*. There are either four or five of these vessels of somewhat varying calibre arranged close together, and thus forming a ladder-like structure lying quite at the anterior end of the liver and running to this from the adjacent border of the stomach. There are no gastro-hepatic veins situated more posteriorly. The interest attaching to this arrangement of the vessels is that it is completely paralleled in *Ophisaurus apus* ||, making allowances for the greater elongation of the liver in the latter snake-like Lizard.

In *Ophisaurus*, in fact, there are six of these veins. Now, as a rule, the Lacertilia have not a great many separate gastro-hepatic vessels. I have myself examined several species embracing as many genera and find the following facts, some of which I have

* *Cf.* pp. 48 & 55.

† P. Z. S. 1905, vol. ii. p. 262.

‡ In contrast to this difference in form between the pancreas of genera which appear to be allied is the close resemblance in another case which I take this opportunity of recording. In both *Iguana tuberculata* and *Liolæmus magellanicus* (I owe the specimen to the kindness of my friend Capt. Richard Crawshay), which are both Iguanidæ, but not much alike superficially, the long splenic lobe of the pancreas just touches the posterior end of the spleen.

§ See P. Z. S. 1905, vol. ii. p. 475, text-fig. 64 *p*. *Anguis* also lacks the splenic lobe.

|| See P. Z. S. 1905, vol. ii. p. 475, text-fig. 64.

already made known in recent communications to the Society upon the anatomy of these Reptiles. In *Iguana tuberculata* I found in two examples two gastro-hepatic veins, and precisely the same arrangement characterised two examples of *Amphibolurus barbatus*. *Uromastix acanthinurus* showed, also in two examples, a single vein, which, however, was made up of three considerable affluents from the stomach; these, it will be understood, entered the liver as a single vessel. In one of the specimens the third affluent only joined the common trunk formed by the other two just before their entrance into the liver. In *Gerrhonotus*, *Tupinambis*, *Chamæleon*, *Phelsuma*, *Tarentola*, I have recorded, or am now able to record, the existence of only one gastro-hepatic vein, which however is, as a rule, made up of two affluents. The Scincidæ form an exception to the general arrangement of these vessels, and at first sight appear therefore to be near akin in this particular to *Gerrhonotus*.

Of *Tiliqua scincoides* I have dissected two examples for the purposes of the present investigation, and find in both of them the following arrangement of the gastro-hepatic veins. There are four of these, which appear at first sight to lie accurately side by side in the gastro-hepatic mesentery. A more careful examination, however, shows that the stomach is bound to the liver by two mesenteries, one above the other, as seen when the animal is opened along the median ventral line and the viscera examined in an undisturbed condition. The lower of these, *i. e.* that which lies above in the ordinary position adopted in dissection, is the gastro-hepatic mesentery found in all Lizards. When this is cut through a second mesentery comes into view, which is attached to the right side of the liver and to the more dorsal side of the stomach. This mesentery exists in other Saurians, but is inserted on to the mesogastrium and does not touch the stomach at all. Whether this arrangement of the right dorsal suspensory ligament of the liver has anything to do with the double umbilical ligament of the same family of Lizards is not certain; but it is found in most but not in all Skinks. I find it in the genus which we are now considering, in *Seps* (*Chalcides*), *Scincus*, *Eumeces*, and *Macroscincus*. It is not to be found in *Trachydosaurus rugosus*. To revert to the gastro-hepatic veins in *Tiliqua scincoides*, the most posterior of the four veins runs along the right or lower (as seen on dissection) gastro-hepatic mesentery; in front of it are two of the veins which run in the upper or left gastro-hepatic mesentery (the mesentery present in all Lizards). Finally, there is a single vein which is inserted just at the junction anteriorly of the lines of attachment of the two mesenteries, to the lower (dorsal) surface of the liver. In *Trachydosaurus*, which, although a member of the family Scincidæ, agrees with other Lizards in the presence of only one gastro-hepatic mesentery, I find in an example dissected only one gastro-hepatic vein, which, as is so usual, is formed by two equally sized affluents. I have some notes, however, of an example, dissected a good many years ago,

in which in addition to this there was another vein further forward at the junction of the two dorsal suspensory mesenteries of the liver. *Macroscincus* is normal—for a Skink—in the presence of two gastro-hepatic mesenteries; and yet it has only one gastro-hepatic vein. This is formed of two equisized affluents, and runs in the right-hand mesentery, the other being quite anangious.

Eumeces algeriensis shows the same double series of gastro-hepatic veins that are to be found in *Tiliqua scincoides*. There is one vein only in each of the two gastro-hepatic ligaments and a third vein implanted at the junction of these anteriorly. As in *Tiliqua*, the medianly situate vein of the three belongs to the left-hand ligament. Of an example of *Chalcides ocellatus*, dissected by me a good many years ago, I have sketches and descriptions showing that this species is more like *Macroscincus** than *Eumeces* or *Tiliqua*. For the gastro-hepatic veins are limited to the right-hand one of the two gastro-hepatic ligaments, with the usual vein which enters the liver at the junction of the two veins. There were in this individual four of these veins in the right ligament. It seems, therefore, that the numerous gastro-hepatic veins of the genus *Gerrhonotus* may be regarded as evidence of affinity with the Anguidæ, since these veins are, as a rule, not numerous among the Lacertilia other than the Anguidæ, Amphisbænidæ, and *Hatteria*, except among the Scincidæ, where the existence of two gastro-hepatic ligaments accounts for the greater number of these veins than occurs in the majority of those genera with only one gastro-hepatic ligament. And, in coming to this conclusion, it must be further borne in mind that the number of gastro-hepatic veins would appear to be fairly constant, so far as the somewhat meagre facts already known allow us to judge. There is but little else in the anatomy of this Lizard, so far as I have been able to record the facts, which bears very distinctly upon its affinities, a conclusion for which the, at present, very small knowledge of the Lacertilia is doubtless largely responsible. It seems, at any rate, to be the fact that *Gerrhonotus* exhibits no marked features in its organisation which point to an affinity with the Scincidæ, except perhaps the condition of the quadrato-jugal ligament, which is undoubtedly like that of *Eumeces*.

(6) *On a Point of Structural Resemblance between* Heloderma *and* Varanus, *and on some Specific Characters of* Varanus.

Although it is not the prevalent opinion that these two genera of Saurians are nearly allied, there are not wanting anatomical resemblances between them; and, indeed, some of the most recent writers † on the anatomy of *Heloderma* have brought together a

* It is perhaps not without interest to notice that in these two genera (*Chalcides* and *Macroscincus*) the double character of the umbilical ligament is not so marked as it is in *Eumeces* and *Tiliqua*. They have, therefore, at any rate, two anatomical features in common.

† Boulenger, P. Z. S. 1891, p. 109; Beddard, *ibid.* 1906, vol. ii. p. 601.

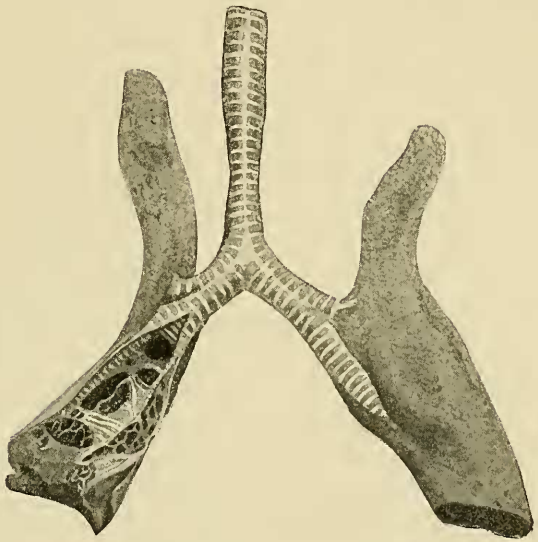
good many facts in favour of such an alliance. On the other hand, Dr. Shufeldt *, who has given us a comprehensive sketch of the anatomy of *Heloderma*, remarked that his own studies of the Varanidæ convinced him "of the fact that *Heloderma* is far removed from that group, having very little structural affinity with it." To these papers cited below, and to others quoted in them, reference may be made for the views which have been held with regard to the position occupied by the genus *Heloderma* in the system.

In recently dissecting examples of these two genera I have noticed two structural features in which the two genera are similar and by which they may be differentiated from any other Lacertilians whose anatomy is known, so far as concerns the points in question. The first of these is a feature in the anatomy of the respiratory organs which has indeed been described in *Varanus* but not in *Heloderma*. As to the former genus, Meckel †, Günther ‡, and Milani §, to whose investigations our knowledge of the anatomy of the respiratory organs in the Varanidæ is chiefly due, describe a short branch given off by the bronchus shortly after it has entered the lung; this supplies the headward extension of the lung which is so well marked in this genus of Lizards. It is plainly figured by Milani ||, whose illustrations ¶, particularly a diagrammatic figure, show that this twig arises in front of an aperture in the walls of the intrapulmonary bronchus. Some of Milani's figures** also illustrate another somewhat important fact, which is that the bronchus until it gives off the branch to which reference has been made does not really lie within the the lung, but outside of it. The lung in growing forward has wrapped round the end of the bronchus. Though apparently within, this portion of the bronchus is really morphologically outside of the lung. The interest attaching to the exact relationship between the bronchus, the lung-tissue, and the first branch of the bronchus appears to me to be this:—that this independent branch arising so early from the bronchus is possibly to be compared with the eparterial bronchus of the Mammalia. This comparison is not suggested by Milani. In any case it is, so far as I am aware, a structure that has not yet been described in any other Lacertilian. A precisely comparable branch of the bronchus occurs, however, in *Heloderma*, where its existence is an interesting feature of resemblance to *Varanus*. I cannot find that any of the writers †† who have described the lung of *Heloderma* have noticed this—to my eyes, very striking—peculiarity of the lung. Nor do the illustrations given by them show any signs of the

* P. Z. S. 1890, p. 233.
† Deutsches Arch. f. d. Phys. 1818, Bd. iv. ‡ P. Z. S. 1861, p. 112.
§ Zool. Jahrb. (Abth. f. Anat.) vii. 1894, p. 581.
|| *Loc. cit.* Taf. 31. figs. 16–18.
¶ *Loc. cit.* p. 581, fig. R, Taf. 32. figs. 19–21.
** Especially fig. 20 of pl. 32 of his memoir.
†† Shufeldt, *loc. cit.* p. 202; Stewart, P. Z. S. 1891, p. 118; Miller, "The Structure of the Lung," Journ. Morph. viii. 1893, p. 170.

eparterial bronchus in *Heloderma*. The length of the bronchi and the complicated structure of the lungs themselves have, however, been remarked upon, and in these matters *Heloderma* also agrees with *Varanus*. The figure (text-fig. 16) shows the commencement of the lungs in *Heloderma suspectum* as seen from the dorsal aspect. The long headward prolongation of each lung, not perhaps sufficiently emphasised in Dr. Shufeldt's figure of these organs, is very reminiscent of *Varanus*. The rings of the trachea are, as correctly stated by Shufeldt, incomplete in the dorsal median line. The bronchi are described by the same writer as "unusually long"; but it is not clear from

Text-fig. 16.



A portion of the trachea, the bronchi, and the upper parts of the lungs of *Heloderma*, from the dorsal side.

The left lung cut open to show the course of the bronchus within it.

the description given, as Prof. Stewart* has pointed out, that this great length does not apply to the intrapulmonary portion of the bronchus. My own measurements of the length of the bronchus up to the place at which it enters the lung agree with those of Prof. Stewart in the case of *Heloderma horridum*. I find this length, in fact, to be as nearly as possible 13 mm. To be absolutely exact is impossible, on account of the pliability of the bronchial rings and interspaces. The bronchi of *Heloderma* are therefore shorter than those of *Varanus* (text-figs. 18 & 19,

* P. Z. S. 1891, p. 120.

pp. 65, 66), and not very much longer than those of a similarly-sized *Iguana tuberculata*. Generally speaking, it is undoubtedly correct to describe the Lacertilia as possessing short bronchi, to which rule, indeed, *Varanus* offers the only very marked exception. The relations of the bronchi to the lungs are not shown in Shufeldt's figure*, where the heart obscures the same, and are wrongly shown in the figure of Miller†. The latter author is wrong (unless, indeed, the lungs of *Heloderma suspectum*, examined by myself, are abnormal) in not indicating, in the figure referred to, a conspicuous branch of the bronchus developed equally on both sides of the body. When the trachea divides, the dorsal median fibrous wall lying between the disjunct ends of the tracheal semirings is continued down each bronchus. As Dr. Shufeldt has remarked, the calibre of each bronchus is not far short of that of the trachea itself. They are, in fact, particularly wide. The ends of the bronchial semirings are, of course, visible on either side of the median fibrous tract. The bronchus approaches the lung and becomes adherent to its mesial side and runs down in contact with it for some distance until it finally enters the lung. At the point of contact the upper ends of the semirings, *i. e.* those lying headwards, cease to be parallel with the lower ends and diverge headwards. The dorsal membranous space ceases, and the semirings in that section of the bronchus which is closely applied to the lung embrace the lung. There is, in fact, a branching of the bronchus, and this short branch may be seen to be lined by cartilaginous semirings for a short distance into the interior of the lung. This is not the case with the following apertures of communication between the bronchus and the lung. I cannot but think that this branch is comparable to that already referred to in *Varanus*. It is further not without importance to notice that this "eparterial bronchus" in *Heloderma* is not serially comparable to the apertures which place the cavity of the bronchus into communication with the interior of the lung and which follow it. For the latter are more ventral in position, as is plainly to be seen in the accompanying figure (text-fig. 16). The "eparterial bronchus" is more dorsal and is, in fact, lateral with reference to the main stem of the bronchus.

The figure (text-fig. 16) which illustrates the branching of the bronchus before entering the lungs also shows on the left side the interior of the lung as seen when the bronchus is slit up after it has given off the branch referred to. I have thought it worth while to introduce this view of the lung of *Heloderma*, since the figure given by Miller‡ does not appear to me to represent quite accurately the mode of communication between the interior of the bronchus and the lung-substance, nor does he indicate the adherence of the bronchus to the lung for a considerable distance before entrance. He does, however, illustrate the important fact

* *Loc. cit.* pl. xvi. fig. 3.
† Journ. Morph. 1893, pl. vii. fig. 5.
‡ *Loc. cit.* pl. vii. fig. 5.

that the bronchus traverses a considerable distance within the lung before it disappears. My own illustration will show that the semirings of the bronchus are complete for a considerable distance, and perfectly easily recognisable, since they show no particular differences from the semirings in the extrapulmonary region of the bronchus. The bronchus communicates with the lung by copious apertures, which are not situated in the region of the bronchus corresponding to the fibrous band which unites the tips of the semirings in the extrapulmonary region of the lung; these apertures would seem to be rather breaks in continuity of the semirings themselves. Their disposition is thus reminiscent of the way in which the rudimentary lung of certain Snakes arises from the bronchus. There is a simple hole in the bronchus which leads into the lung in the case of those Snakes.

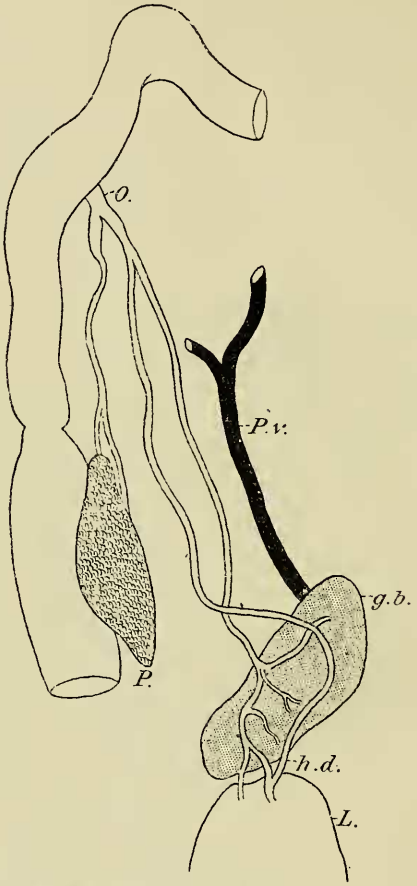
In a paper communicated to this Society a good many years since* I described the complicated branching of the cystic duct and its anastomosis with the hepatic duct in *Varanus salvator*. I have since then discovered that the same network, comparable to that which is found so generally among the Ophidia, occurs also in *V. gouldii*, though it is in that species rather less developed than in *V. salvator*. Quite recently I have dissected out the bile-ducts in *V. niloticus*, of which species I have had the opportunity of examining several very small examples preserved in spirit. I had one of these injected from the gall-bladder, and the injection (chrome-yellow rubbed up in olive-oil) ran readily along the branches of the cystic and hepatic ducts. The accompanying figure (text-fig. 17, p. 64) is fairly accurate (but I fear not absolutely so) as regards the network, which, as will be seen, is much like that of *V. salvator*, but perhaps not quite so complicated. Moreover, when once the hepatic and cystic ducts have left the surface of the gall-bladder there are apparently no further anastomoses between them, as there are—though to a limited extent—in *V. salvator*. On the other hand, there are some species of *Varanus* in which there is no network formed by the bile-ducts on their emergence from the gall-bladder (as is also found among the Ophidia). To some of these I have referred in my communication just quoted. I have since carefully examined *Varanus exanthematicus*, and find that the cystic duct emerges as, and continues to be, a simple duct throughout. The same is the case with *V. griseus*. It is not wise perhaps to generalise on these few data; but so far as the facts go they agree with an important external character by which the species referred to may be grouped. In *V. salvator*, *V. gouldii*, and *V. niloticus* the nostril is a circular aperture, while in the other species mentioned it is obliquely placed and slit-like.

In all the species of *Varanus* that have been referred to in the

* P. Z. S. 1888, p. 106. The illustrative figure (fig. 4, p. 105) has been copied in Gegenbaur's 'Vergl. Anat. Wirbelth.'

present communication the pancreas is a solid body, as shown in the figure of that of *V. niloticus* (text-fig. 17). In all of them a

Text-fig. 17.



Pancreas, gall-bladder, &c. of *Varanus niloticus*, to show the course of the bile-ducts.

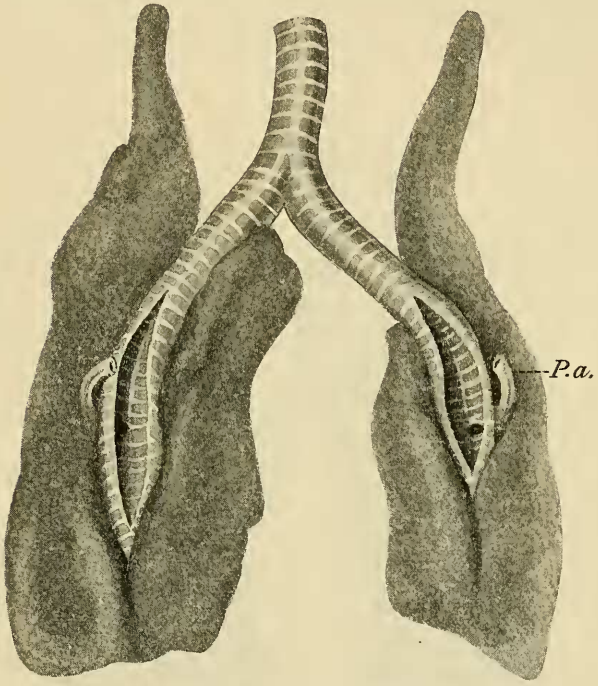
g.b. Gall-bladder; *h.d.* Hepatic ducts; *L.* Liver; *O.* Orifice of conjoined bile-ducts; *P.* Pancreas; *P.v.* Portal vein.

very slender splenic lobe arises near to the anterior end of the pancreas and passes to the spleen *. The species, however, show

* In *Varanus exanthematicus* the end of the splenic not merely touches, but enwraps and is enwrapped by the spleen. This intimate relation between the spleen and the pancreas recalls a similar close association occasionally found among the Ophidia.

certain differences among themselves in the position of the duodenum with reference to the pancreas. In *V. niloticus* the pancreas is separated by a considerable tract of mesentery from the duodenum, which results in the exposure of a long pancreatic duct. The same is the case with *V. ocellatus*. On the other hand, in *V. griseus* and *V. exanthematicus* the end of the pancreas touches the duodenum close to the point of entrance of the pancreatic and bile ducts, and there is therefore no great length of pancreatic duct.

Text-fig. 18.



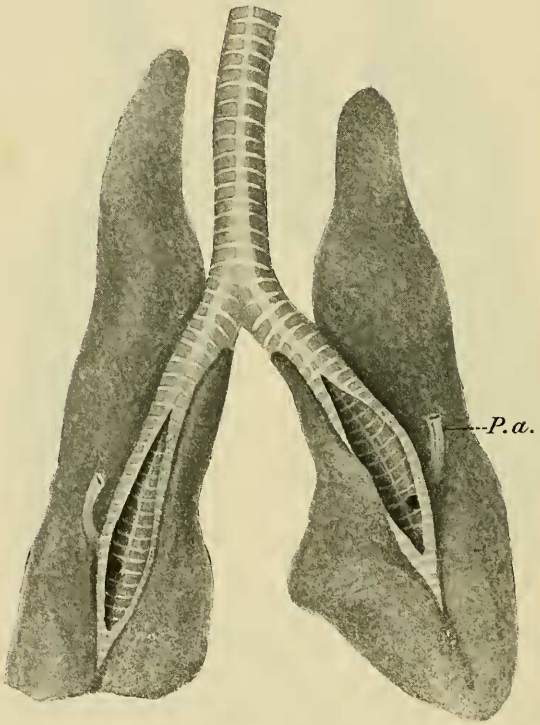
Lungs of *Varanus exanthematicus*.

Bronchi opened to show exit of "eparterial bronchi" close to pulmonary artery (*P.a.*).

In his figures of the lung of several species of *Varanus*, Milani has pointed out certain differences which distinguish them. Thus the lungs of *V. bengalensis* are lobed externally in a fashion which is not to be found in the other species which are described. In examining, for the purposes of the present communication, the lungs of several species of *Varanus*, I have observed two small points of difference between the lungs of certain species which are not referred to by Milani. Of these both involve an asymmetry

or symmetry of the lungs and the windpipe as the case may be, not, indeed, in point of length, which is a common feature among Lizards and one of the most obvious features in which they approach the Snakes. This asymmetry, when it occurs, affects the position of the "eparterial bronchus" and the ventral forward projection of the lung between the bronchi. In *Varanus griseus* (text-fig. 19) the left lung, as well as the right lung, sends forward towards the bifurcation of the bronchi a thin diverticulum, which has an entire cavity not divided by any meshwork and seems to be comparatively unvascular. This can readily be lifted up and is seen to be not attached to the bronchus of the lung of which it is an outgrowth.

Text-fig. 19.



Lungs of *Varanus griseus*. Details as in text-fig. 18.

So far, therefore, the lungs are symmetrical. But the origin of the eparterial bronchus is not symmetrical. On the right side this branch arises from the bronchus at a distance of 27 mm. from the point of bifurcation of the bronchi; in the case of the left

lung this distance was only 21 mm. A second specimen showed precisely the same relations in all these points of structure. Contrasted with this (compare text-figs. 18, 19) are the different conditions observable in *Varanus exanthematicus*. In the latter species (text-fig. 18, p. 65) the two branches of the bronchi were exactly symmetrical and each was situate 33 mm. from the bifurcation of the bronchi. Only the right lung gave off a forwardly directed lobe situated on the inner side of its bronchus. There was nothing to correspond in the left lung. I have not been able to compare these conditions with those of many other species of *Varanus*. But in both *V. ocellatus* and *V. niloticus* there was precisely the same asymmetry in the relative positions of the branch of the bronchus, which in all cases lies behind the aorta of its side.

Summary of more important new Facts contained in this Communication.

In view of the fact that very few genera and species of Lacertilia have been studied anatomically, it is a little difficult at present to differentiate between more and less important structural details as evidence of affinities between different genera. The following *résumé*, therefore, will be necessarily only an attempt to lay stress upon what appear at present to be the more important new facts which I have set forth in this communication.

(1) The *pancreas* in the Lacertilia, as already known, differs in different genera. I have added to the existing knowledge some new facts with regard to genera and species not examined by others. It appears from this that the chief variability in the pancreas consists in the presence or absence of a splenic lobe and in the relations of the latter to the spleen. The classificatory importance of the facts does not appear to be great; since, though the Iguanoids, *Iguana* and *Liolæmus*, are like each other in the relations between the splenic lobe of the pancreas and the spleen, we find in *Varanus* and *Chamæleon* differences between different species in these points. The pancreas is nearly always a compact gland; but not so in *Zonurus*.

(2) The variations in the structure of the viscera among the Chamæleons concern principally the proportions between the two lobes of the liver, the form of the diverticula of the lungs and the absence or presence of these, the degree of pigmentation of the body-cavity, and the degree of coiling of the intestines.

(3) The variations in the structure of the viscera in the different species of *Varanus* concern principally the presence or absence of a bile-duct network and certain minute differences in the lungs. It seems possible that those species with a round nostril are distinguished from those with an oblique slit-like nostril by the possession of this network.

(4) The simplicity of structure which is often associated with small-sized forms as compared with their allies of larger size is

well seen in the two small species of Chamæleons, viz. *Ch. pumilus* and *Ch. tæniobronchus*, where the lungs have no diverticula and the intestinal tract is nearly straight.

(5) The very general presence of a gubernaculum cordis among the Lacertilia renders its absence in *Zonurus* a matter worthy of comment.

(6) The most important fact, perhaps, which I have been able to ascertain is the persistence in several genera of Lacertilia of considerable remains of the fourth visceral arch (second branchial). This is a fair-sized bar of cartilage which does not make any connection with the copula below. The existence of this arch has, however, been recorded in the adult *Lacerta* by the late W. K. Parker.

(7) The two genera *Varanus* and *Heloderma* (which are quite remote from each other in some structural features) agree with each other in that each bronchus is adherent to its lung for some little distance before it enters it, and emits a short branch to the upper end of the lung before it becomes confluent with the lung.

(8) It is interesting to note the double gastro-hepatic membrane in certain Scincidæ, which is associated with a correspondingly double set of gastro-hepatic veins, as distinctive of that family, though not universal.

4. A List of Moths of the Family *Pyralidæ* collected by A. E. Pratt in British New Guinea in 1902–3, with Descriptions of new Species. By George H. Kenrick, F.Z.S.

[Received December 8, 1906.]

(Plates III. & IV.*)

This collection was made under circumstances mentioned by Mr. Pratt in his book 'Two Years among New Guinea Cannibals,' published in 1905, and beyond the fact that most of the specimens were taken at light very little information can be given.

The country in which the collections were made appears in some of its characters to resemble Darjiling: there are the same precipitous ridges with narrow valleys between, all with a background of snowy mountains of great elevation, and everywhere there is much dense forest. The climate, with its abundant rain in the wet season and brisk air in the dry season, is also similar, while an abundant lepidopterous fauna completes the resemblance.

Although most of the insects were taken at light, in most cases females were well represented and the condition of the insects is extremely good.

* For explanation of the Plates, see p. 87.